Agilent Drinking Water Analysis solutions

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"**DSP** *Chromatography*" d.o.o.

Agilent Life Science and Chemical Analysis Overview

Agilent in Life Sciences and Chemical Analysis

Life Sciences

Pharma, Biotech, CRO, CMO

Academia & Government

Clinical Diagnostics DX

Chemical Analysis

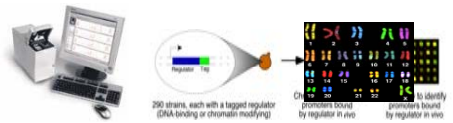
Petrochemical QA/QC

Environmental Testing

Food Testing

Forensics Testing

Life Sciences Tools



Spectroscopy Tools

Separations Tools

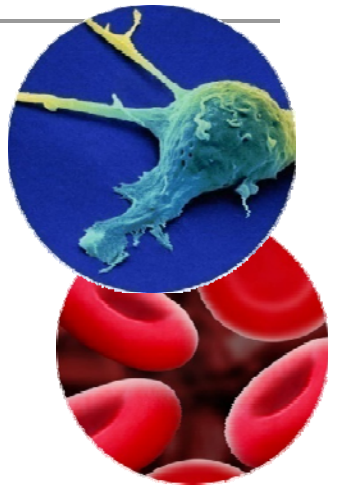
Consumables

Services & Informatics

Agilent Technologies

Agilent LSCA Value Proposition

We will help labs produce better results faster with:



Products: Broad portfolio of reliable workflow solutions

Advice: Optimize customer applications and lab operations

Software: Easy to use, open systems to maximize lab productivity

Services: Responsive support, highest uptime

"Our Measure is Your Success"

Environmental Industry Segmentation

Testing & Analytical Services

Provide testing of soil, water, and air for regulatory monitoring and compliance

- Independent labs
- Government labs
- Municipalities
- Industry
- Environmental consultants
- Remediation contractors

Drivers:
- Profitability
- Cost-per-analysis
- Regulatory compliance
- International commerce

Water Utilities & Treatment Works

Provision and distribution of safe drinking water

- Municipalities, Industry, Consumers

Collection and treatment of residential, commercial and industrial wastewaters

- Municipalities, Industry

Drivers:
- Regulatory compliance & monitoring
- Consumer health & safety
- Cost-per-analysis

Hazardous Waste Management

Manage on-going hazardous waste streams

- Industry (i.e, electronic producers, chemical & petroleum companies)
- Government agencies

Medical waste

Nuclear waste

Drivers:
- Profitability
- Regulatory compliance & monitoring
- "Green" image

Remediation Services

Physical cleanup of contaminated sites, buildings and cleaning up of soil, groundwater or operating facilities

- Government agencies
- Property owners
- Industry

Drivers:
- Time-to-result
- Cost-per-analysis
- Politics

Application Area #1 Semi-volatiles analysis

What Are They Testing & What Are They Testing For? Key Applications/Workflows

Semi-volatile compounds in water

Majority for a large prescribed list, such as EPA 8270 or EPA 625 but there are many regional variations.

Combined method for PCBs and PAHs is very popular.

Also similar approach to many other compound classes;

- PAHs
- PCBs
- Pesticides
- Other POPs

Several method variations by matrix, region and target list

Improve Productivity and Useable Sensitivity in Semi-Volatiles Analysis with Agilent's 7890A/5975C GC/MSD

Vials, liners, syringes and septa for an inert flow path

Semi-volatiles Retention Time Locked Databases

ALS overlap

PTV inlet

Deconvolution Reporting Software

Backflush and other Capillary Flow Technologies

Triple-Axis Detector

Fast oven

Trace Ion Detection

GC columns for fast analysis and inert performance

Gain normalized auto tuning

Customer Pain Points: Productivity Matters

Speed of analysis!.

Matrix, matrix, matrix.

Maintenance causes downtime.

Sensitivity, identification and quantification

Calibration requirements

Agilent Products That Address Customer Pain Points

Speed matters!

- Fast columns, fast oven, backflush

Matrix, matrix, matrix.

- Capillary flow technology, DRS, Trace ion detection

Maintenance causes downtime.

- Quickswap, Duraguard columns, inert source, backflush

Sensitivity, identification and quantification

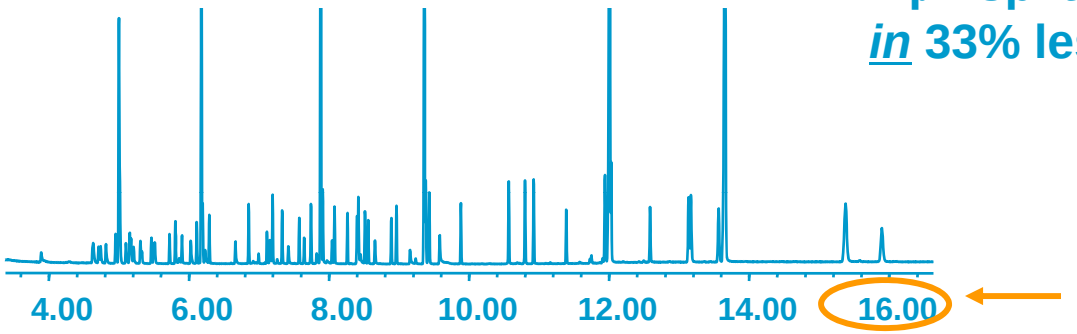
- LVI by PTV, SIM/SCAN, Trace ion detection, inert source, DRS and RTL libraries; Triple axis detector

Calibration requirements

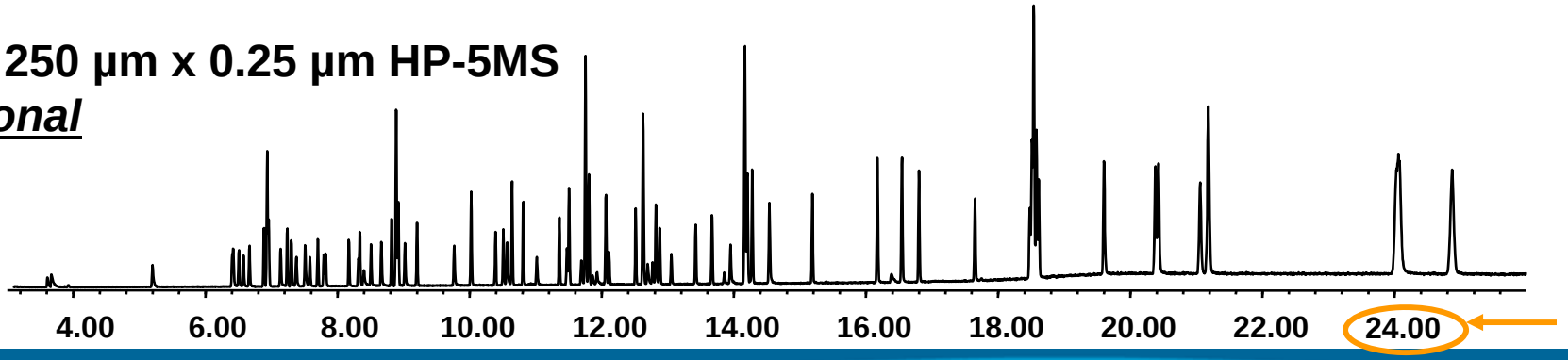
- Capillary flow technology, inert source, Gain normalized auto tuning, RTL

83 Semivolatiles on 3 Different Columns.

20 m x 180 µm x 0.36 µm DB-5.625
1 µL splitless injections maintain MDLs *in* 33% less time.



30 m x 250 µm x 0.25 µm HP-5MS
Traditional

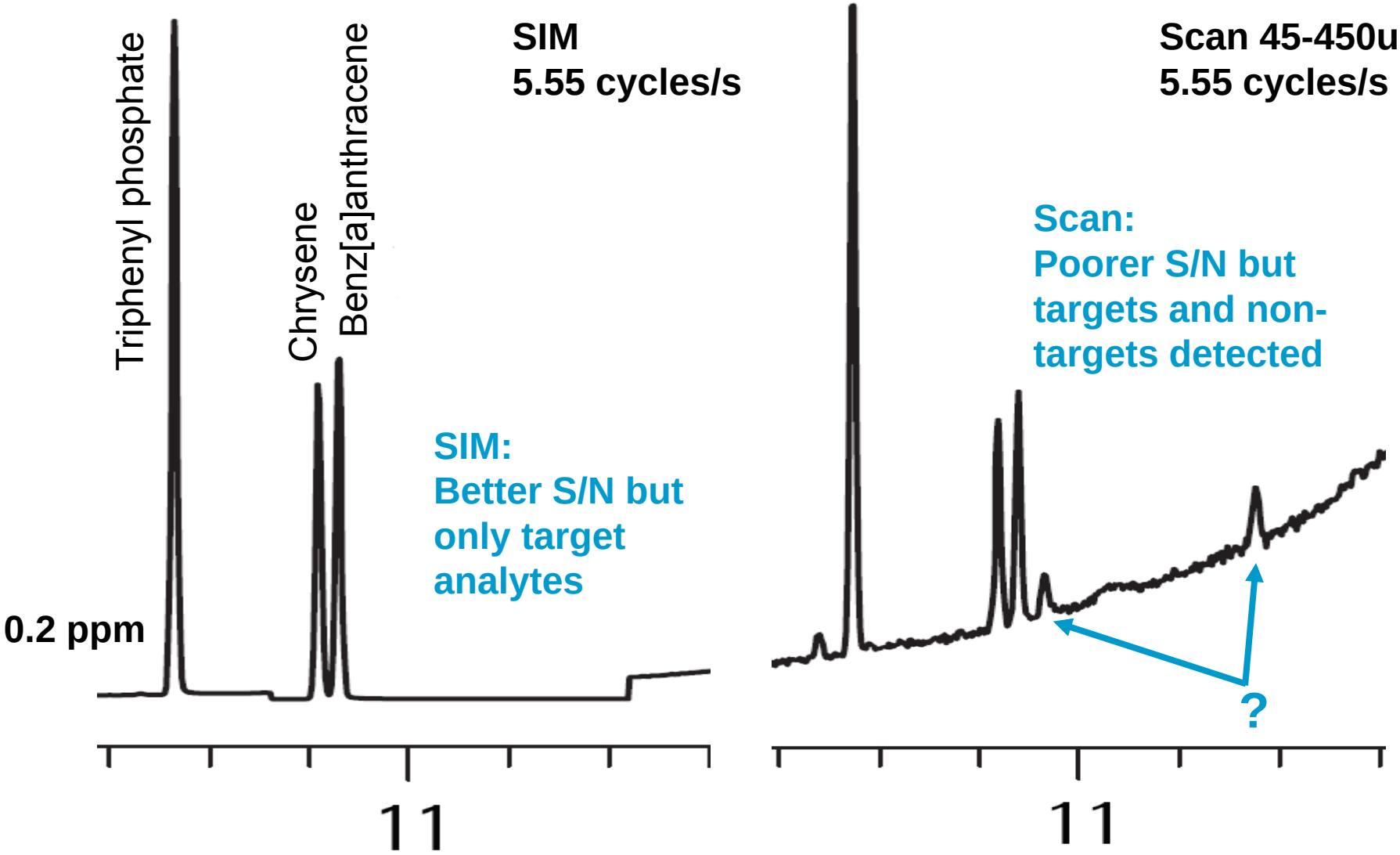


Cycle Time Reduction = Productivity Gain

	Yesterday's Typical System	Today's 7890 5975	Minutes Saved
Run Time, 250 µm *vs* 180 µm column	25	17	8
Run time, matrix bake-out *vs* Capillary Flow Tech	50	21	29
Cool down time from 320 °C to 40 °C	7	3.3	3.7
Total time savings using a 7890-5975, narrower bore column and backflush	57	24.4	32.6

Time Savings > 50 % => Run Twice the Samples/Day = $$$$

Synchronous SIM/Scan Comparison of PAHs

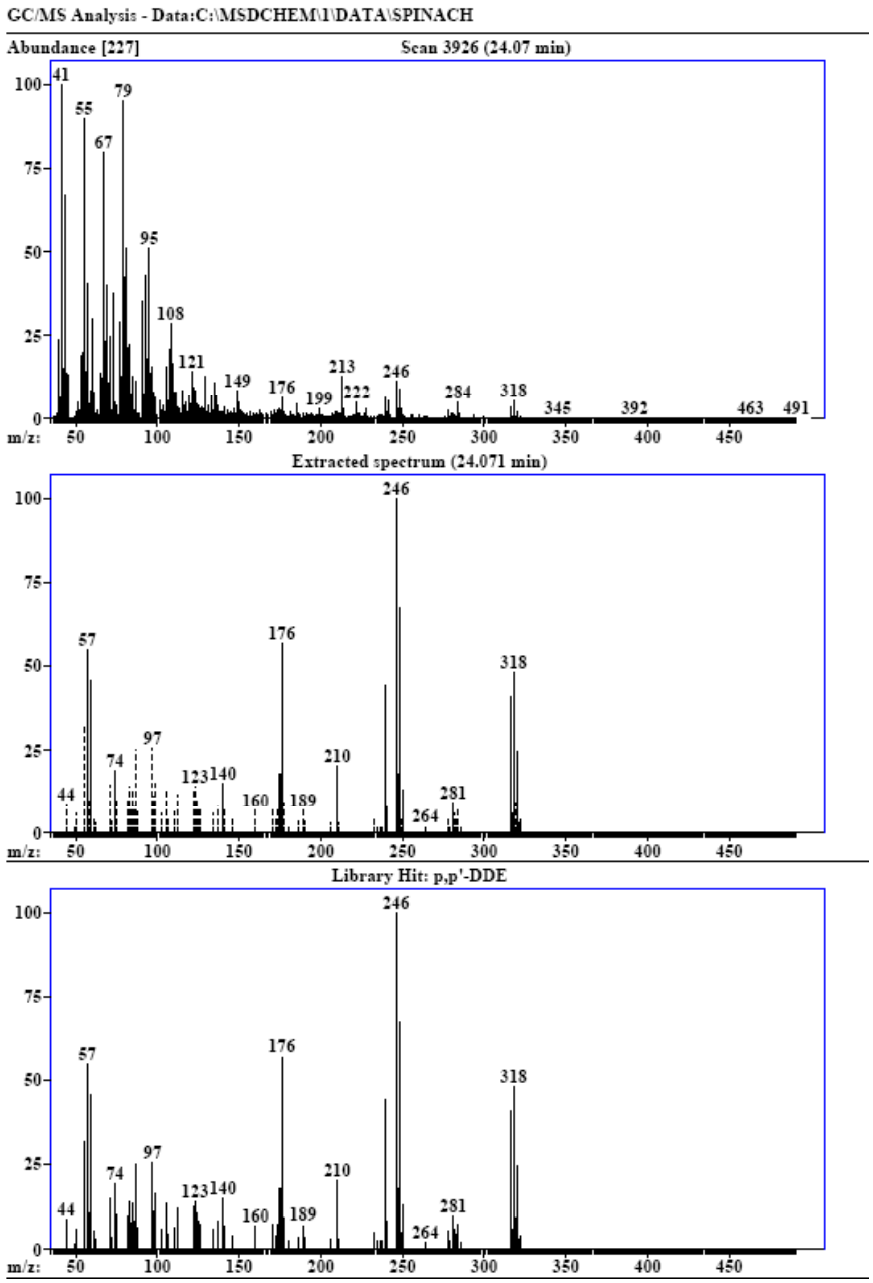


Raw spectrum

Deconvoluted spectrum

p,p’-DDE

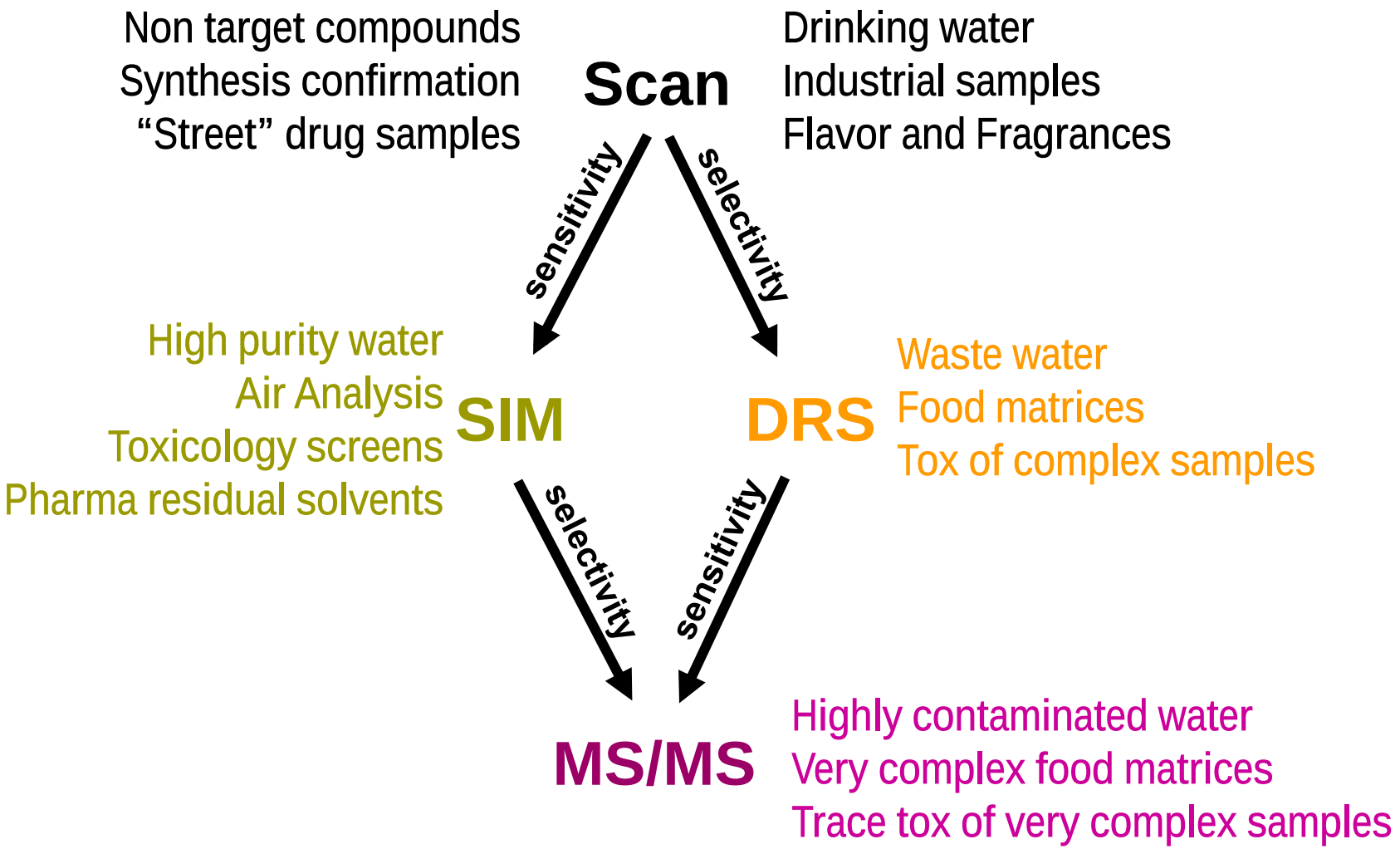
Library spectrum



The matrix ions results in false negative

DRS enables a positive identification

Application Alignment with MS Modes



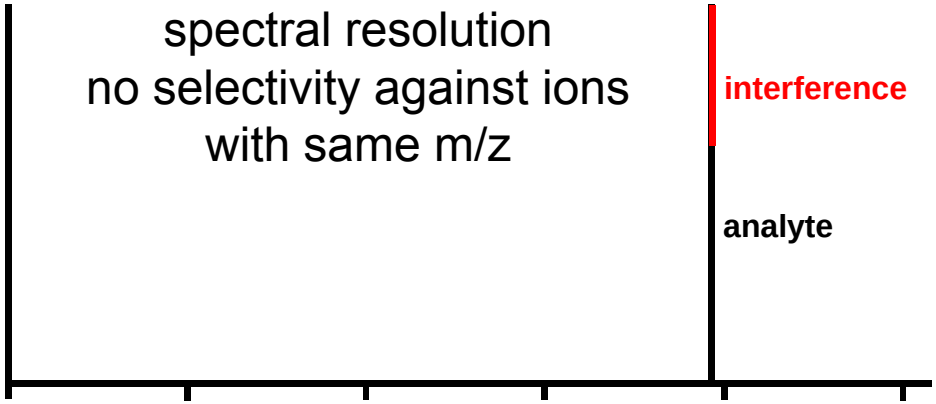
Analytical Reality of GC/MS/MS Methods

- With the selectivity of MS/MS, the **user cannot see the matrix**
  - Hundreds and even thousands of matrix peaks are “invisible” in MS/MS mode
- MS/MS users want the LOWEST detection limits, so they inject even more sample into the GC/MS/MS system with PTV in LVI mode
  - “Invisible” matrix peaks are even **MORE intense**
- Many late eluting peaks are not “chromatographically ideal” and leave a residue throughout the column
  - This residue **increases with each subsequent injection**
  - Matrix carryover increases as more samples are injected
- Heavy matrix contaminates the source faster and **sensitivity is LOST**!

MS/MS Eliminates Scan and SIM Interferences

Single Quad MS

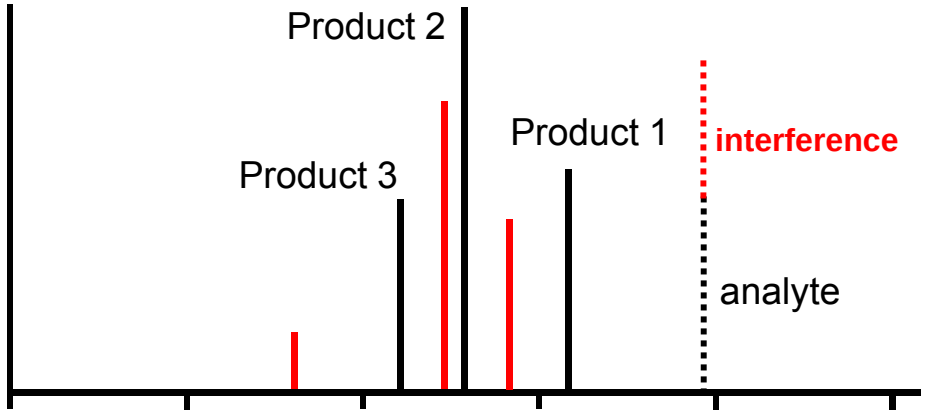
selectivity proportional to spectral resolution
no selectivity against ions with same m/z



unit mass resolution

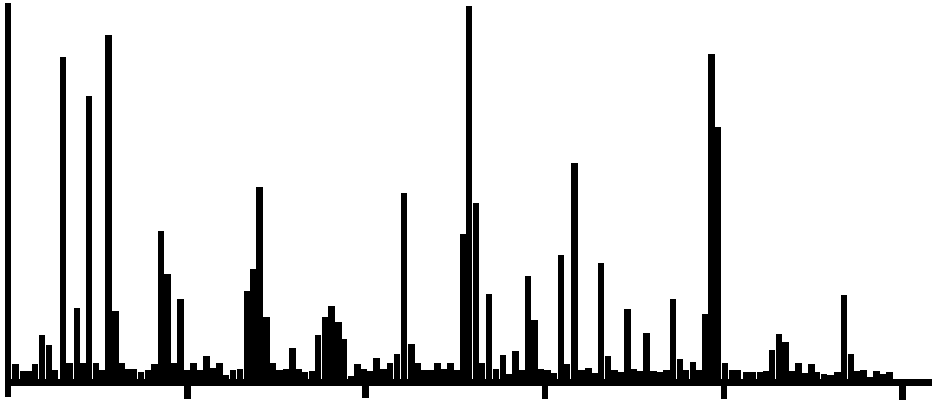
Triple Quad MS

Precursor selectivity same as MS <u>but</u> high probability that one or more of the product ions will be a unique dissociation product of the precursor <u>only</u>
AND NOT the interference



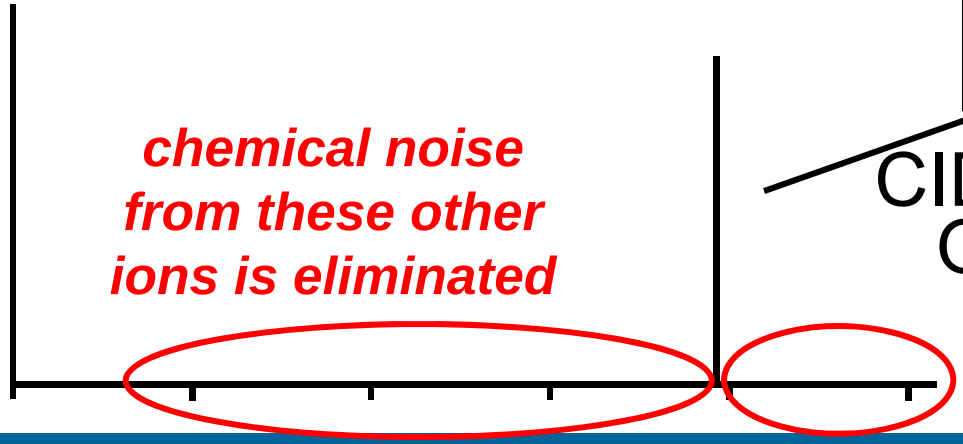
MS/MS Ensures Lowest Detection Limits

EI: spectrum of analyte can also include ions from matrix, column bleed, gases, etc.



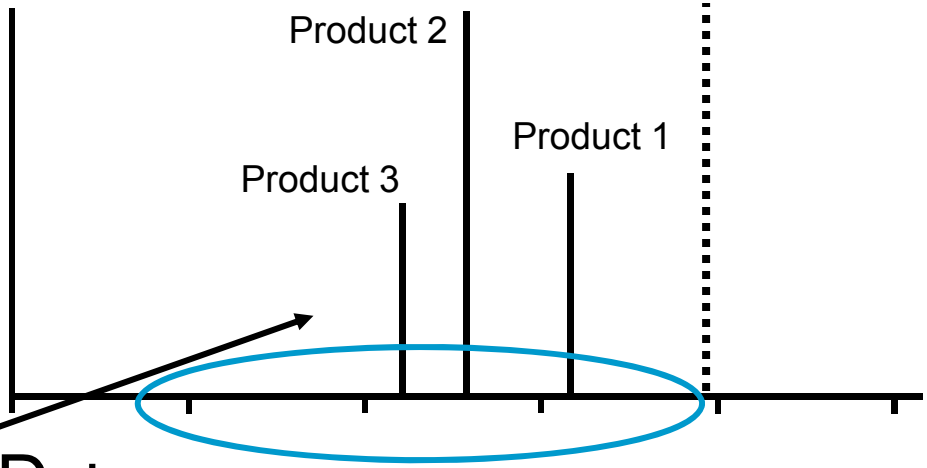
Q1 SIM

isolate precursor before CID



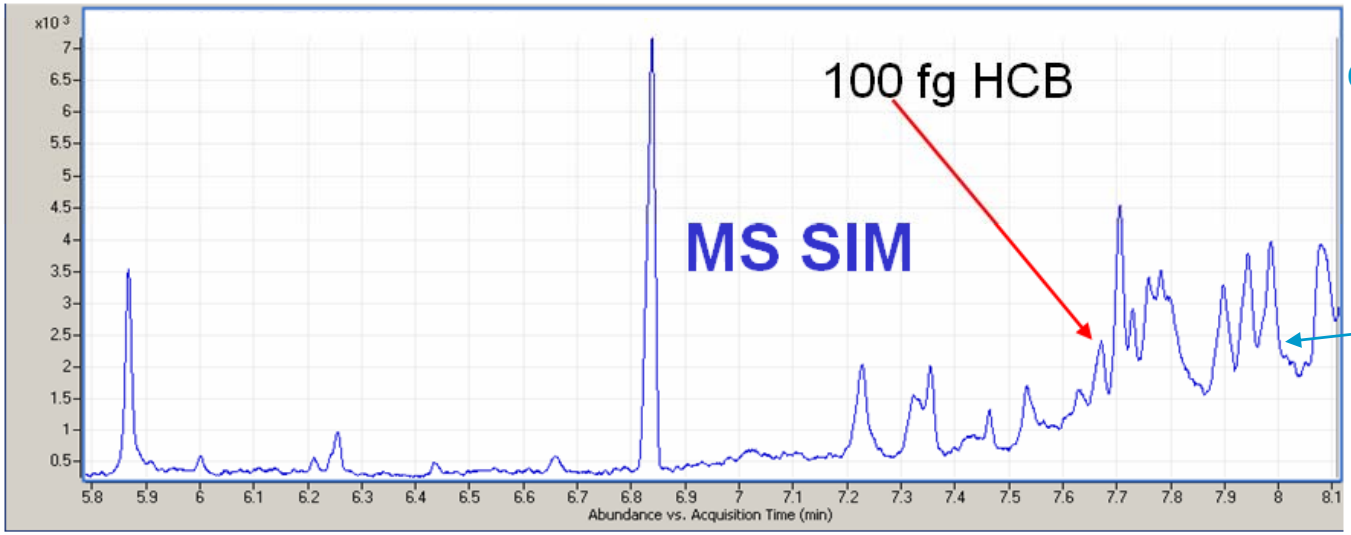
chemical noise from these other ions is eliminated

CID + Q2 SIM



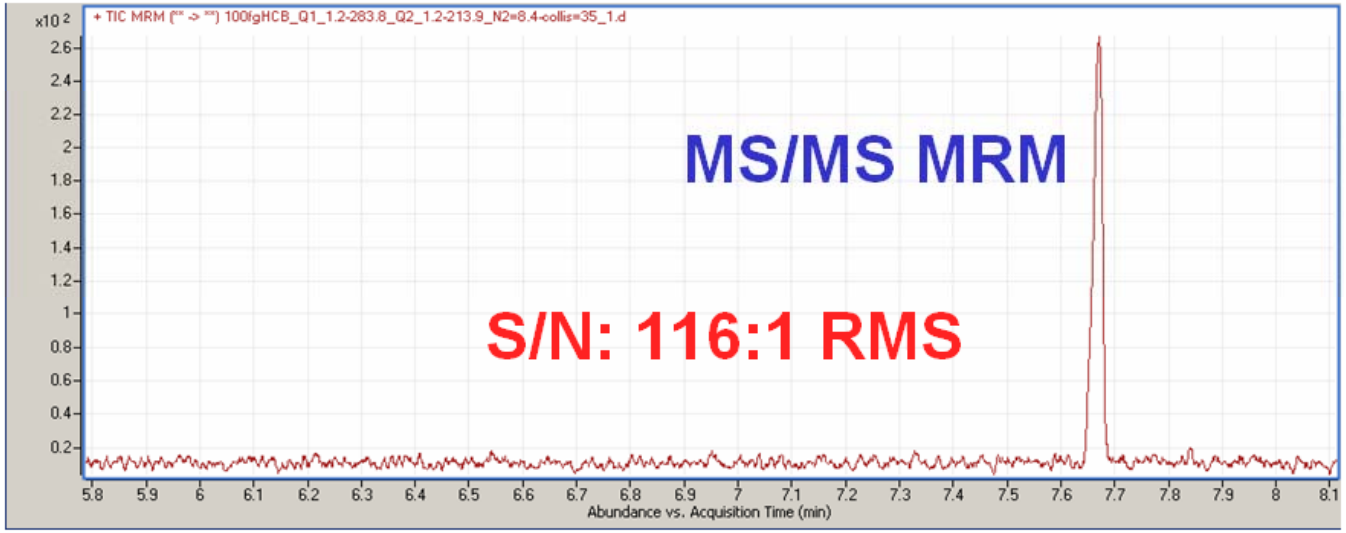
Lower m/z Product Ions measured against zero chemical noise

MS/MS Succeeds Where MS Fails



GC/MS Single Quad SIM

Interfering matrix peaks = chemical noise



GC/MS Triple Quad SRM

A chromatographer's dream: single peak on flat baseline

Designed for Performance and Reliability

Making femtogram level sensitivity and high speed SRM accessible to a wide range of users

- Leading sensitivity: 100fg of OFN at 100:1 RMS S/N
- High performance SRM (MRM) with 500 transitions /sec speed
- New proprietary hexapole collision cell technology
- Reliable, heated gold plated hyperbolic quartz quadrupoles
- Agilent 7890 GC with Capillary Flow technology
- MassHunter Software

Gold Plated Hyperbolic Quartz Quadrupole

Agilent 7000A Triple Quadrupole GC/MS

Application Area #2

Volatiles analysis in the environmental market

What are they testing & what are they testing for? Key Applications/Workflows

Testing for a fairly standard list of regulated organics in water, waste water, drinking water

Requirements, list and methodology vary by region.

- Purge and trap in the Americas and parts of Asia
- Headspace in the EU

The sampler often drives the decision from the customer

Agilent Solutions

The 7890/5975C is the heart of the Agilent volatiles solution.

We also offer a range of sample introduction options that form an integrated solution for volatiles.

- Regional requirements
- Customer preference
- Channel pressu

Tekmar P&T sampler

Agilent 1888A SHS

CTC SHS sampler

Customer painpoints

Productivity: Speed of analysis and cycle time

Purge and trap water management and reproducibility

Quick identification and confirmation of target analytes

Sensitivity that meets method requirements

Calibration requirements

- Reproducibility that meets method requirements (hold tune and calibration? How long?)

Agilent Products to address pain points

Productivity: Speed of analysis and cycle time

- J&W Scientific columns
- 7890 oven speed

Purge and trap water management and reproducibility

- Improved sampler options and performance

Quick identification and confirmation of target analytes

- RTL
- Volatiles libraries
- DRS software

Sensitivity that meets method requirements

- 5975C triple axis detector
- inert source
- Synchronous SIM/SCAN
- Trace ion detection

Reproducibility that meets method requirements

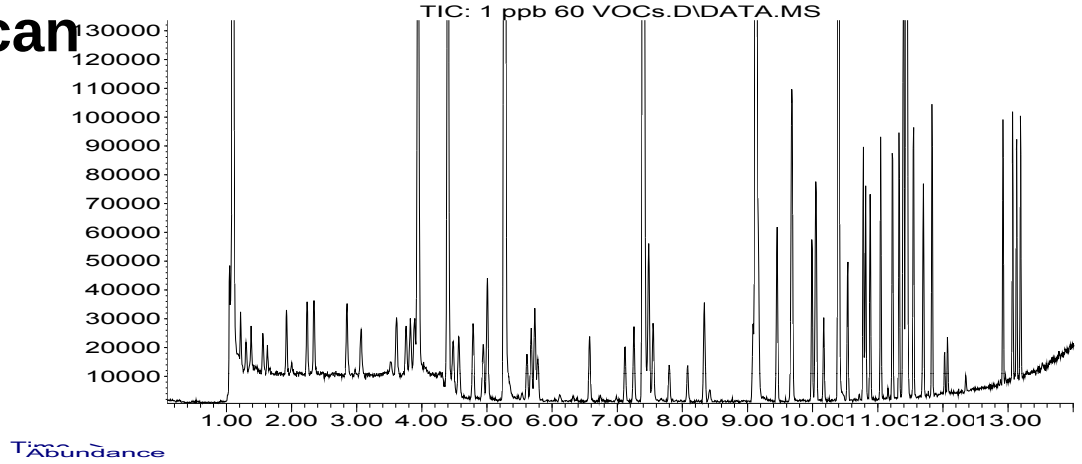
- Sampler performance
- 7890 pneumatics
- Inert source

Calibration requirements

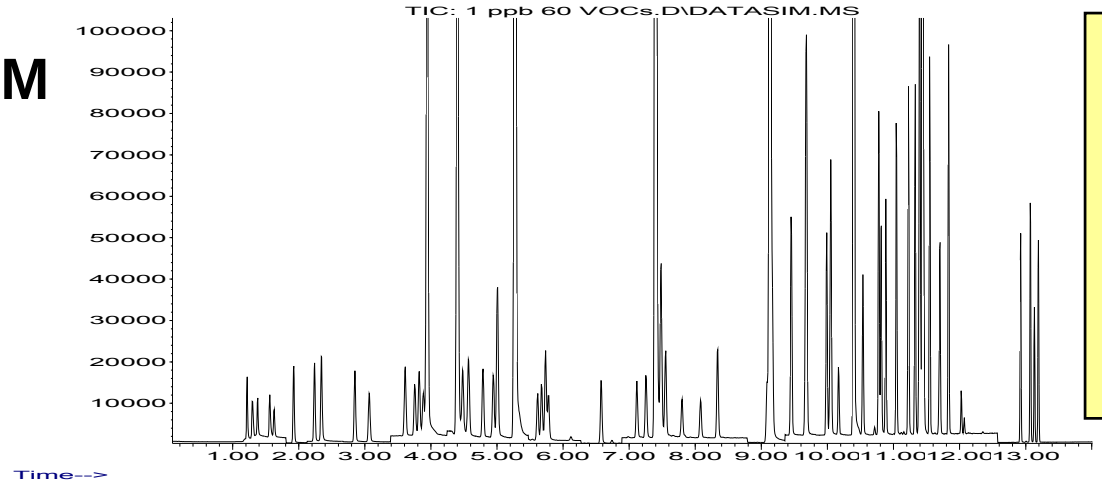
- Agilent inlet supplies
- Gain normalized autotune

EPA Method 8260 (Volatiles in Wastewater) Using the New Agilent 5975 Inert MSD

Scan



SIM



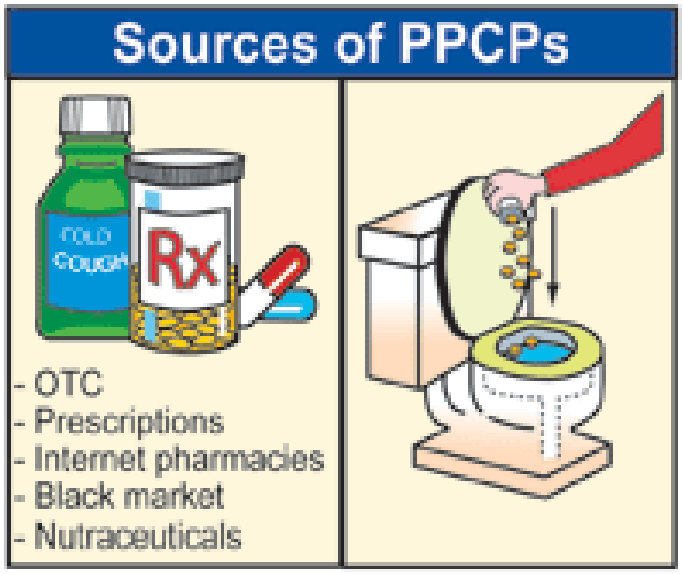
- Velocity XPT/6890N/5975 P&T/GC/MS system
- 20 m X 0.18 mm X 1.0 µm DB-VRX column
- Sampling rate = 2 scan; Dwell =20 ms for SIM

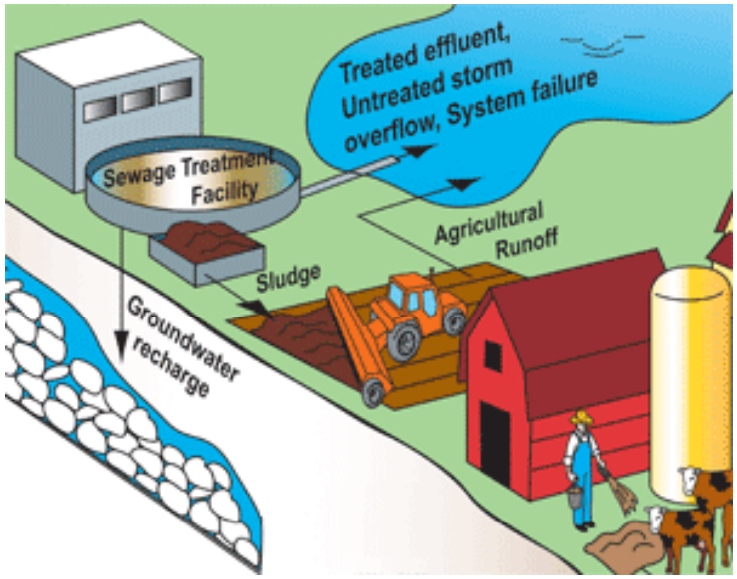
Scan and SIM Chromatograms from SIM/Scan Analysis of 60 VOCs at 1 ppb

Application Area #3

Emerging Contaminants in the Environmental Market

1. Perflorinated organics
2. PPCP
3. EDC's





Who Does the Testing?

- The most interest is in the water industry, municipal, regional and state water suppliers
- Migration to top independent labs has been slow
- Driver: Public concern over purity of water and not necessarily a regulatory concern. Yet!

Water Utilities & Treatment Works

Provision and distribution of safe drinking water

- Municipalities, Industry, Consumers

Collection and treatment of residential, commercial and industrial wastewaters

- Municipalities, Industry

Drivers:

Regulatory compliance & monitoring
Consumer health & safety
Cost-per-analysis

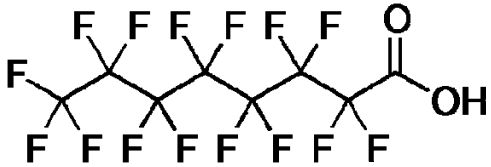
What Are They Testing & What Are They Testing For? Key Applications/Workflows

PPCP: Pharmaceutical and personal care products

PFOS/PFOA: Perflorinated compounds used in paper and fabric treatments

EDC: Endocrine disruptor compounds, wide range of compounds from flame retardants to phyto-estrogen mimic compounds

What Are They Testing?



Environmental analysis trends - Emerging Contaminants
Need for screening methods, confirmation and quantitation of positives only i.e. EU Water Framework Directive
Need for "ready to use" methods of analysis including sample preparation i.e. EPA 1694
Increased number of samples in labs, need for a data management solution
Need for multicomponent analyses
Less sample prep
Need for faster analysis methods, doing more analyses in a day Rapid Resolution, valve solutions

EPA

Acetaminophen
Albuterol
Ampicillin
Anhydrochlortetracycline (ACTC)
Anhydrotetracycline (ATC)
Azithromycin
Caffeine
Carbadox
Carbamazepine
Cefotaxime
Chlortetracycline (CTC)
Cimetidine
Ciprofloxacin
Clarithromycin
Clinafloxacin
Cloxacillin
Codeine
Cotinine
Dehydronifedipine
Demeclocycline
Digoxigenin
Digoxin
Diltiazem
1,7-Dimethylxanthine
Diphenhydramine
Doxycycline
Enrofloxacin
4-Epianhydrochlortetracycline (EACTC)
4-Epianhydrotetracycline (EATC)
4-Epichlortetracycline (ECTC)
4-Epioxytetracycline (EOTC)
4-Epitetracycline (ETC)
Erythromycin
Erythromycin anhydrate
Flumequine
Fluoxetine
Gemfibrozil

Antibiotics

Ibuprofen
Isochlortetracycline (ICTC)
Lincomycin
Lomefloxacin
Metformin
Miconazole
Minocycline
Naproxen
Norfloxacin
Norgestimate
Ofloxacin
Ormetoprim
Oxacillin
Oxolinic acid
Oxytetracycline (OTC)
Penicillin V
Penicillin G
Ranitidine
Roxithromycin
Sarafloxacin
Sulfachloropyridazine
Sulfadiazine
Sulfadimethoxine
Sulfamerazine
Sulfamethazine
Sulfamethizole
Sulfamethoxazole
Sulfanilamide
Sulfathiazole
Tetracycline (TC)
Thiabendazole
Trimethoprim
Tylosin
Virginiamycin
Warfarin
Other standards

Pain Killers

Birth Control Steroids

Anti-Depressants

Agilent Technologies

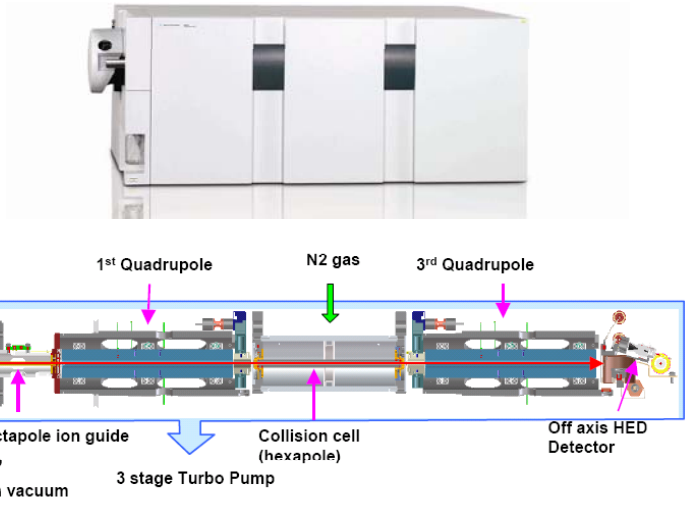
Agilent Solutions

For target screening:

- Agilent 1200 coupled to the Agilent 6410 or 6460 LC/MSMS
- Agilent 7890 with either the 5975C GC/MS or the 7000A GC/MSMS

For non-target identification and quantification:

- Agilent 1200 coupled with the 6220 TOF or 6520 Q-TOF



Customer Painpoints

"Newness" of the LC/MS technology.

- These labs have historically been dedicated to GC/MS solutions
- Learning curve

Budget concerns in the public sectors

Sensitivity requirements, performance requirements

Productivity requirements

Customer Pain Points

Newness and learning curve

- MassHunter software, familiar Agilent hardware

Productivity

- RRLC from the 1200, MRM speed, pos/neg switching

Budget concerns in the public sectors

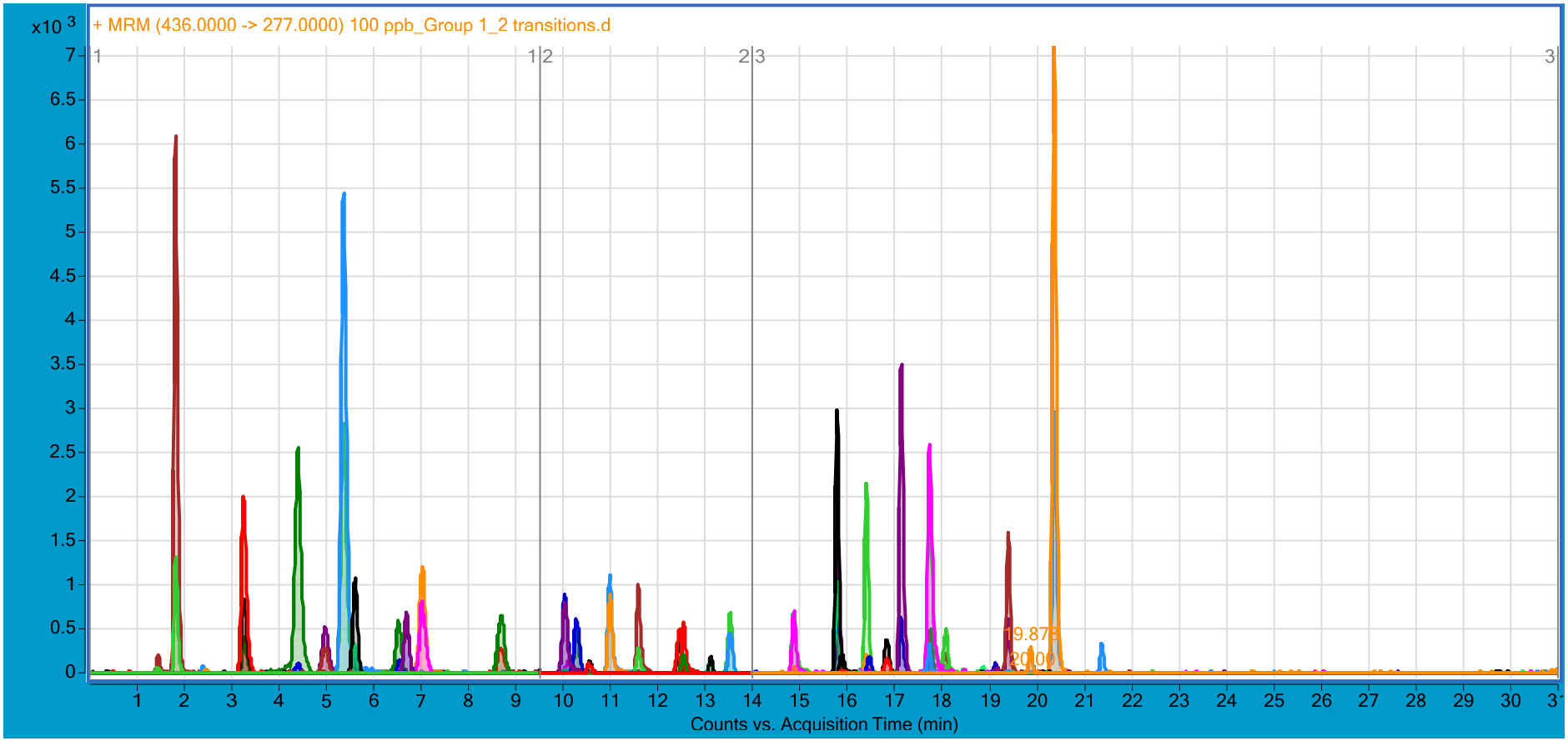
- Excellent price/performance ratio

Sensitivity requirements, performance requirements

- Femtogram sensitivity from the 6460

Method 1694 Group One Compounds by LC/MS/MS

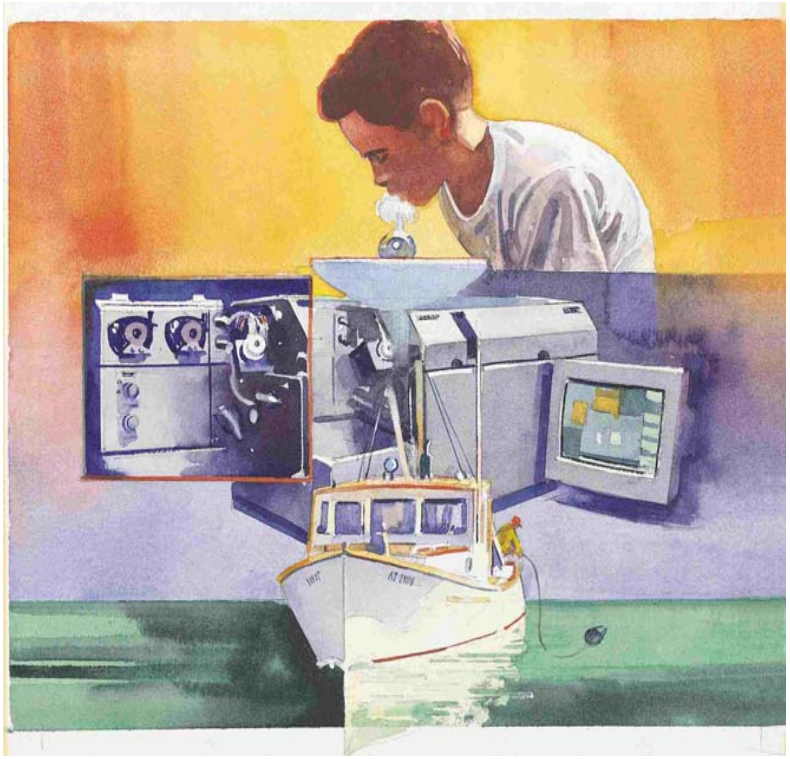
Agilent Improvement: 2 Transitions and 3 Time Segments



Agilent Technologies

Application Area #4

Metals analysis in the environmental market



What Are They Testing & What Are They Testing For?

Primarily driven by **regulatory requirements for toxic metals** in:

1. Drinking waters and wastewaters
2. Soils and sludges
3. Hazardous wastes

Worldwide, most regulations and methods are based on these two EPA methods.

EPA 6020(a) **Trace metals in waters and wastes according to requirements of the *Resource Conservation and Recovery Act* (RCRA) as published in SW-846**

- **Applicable to: Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Tl, V, Zn**

EPA 200.8 **Trace metals in drinking water according to requirements of the *Safe Drinking Water Act* as published in 40CFR part 141**

- **Applicable to: Al, Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Th, U, V, Zn**

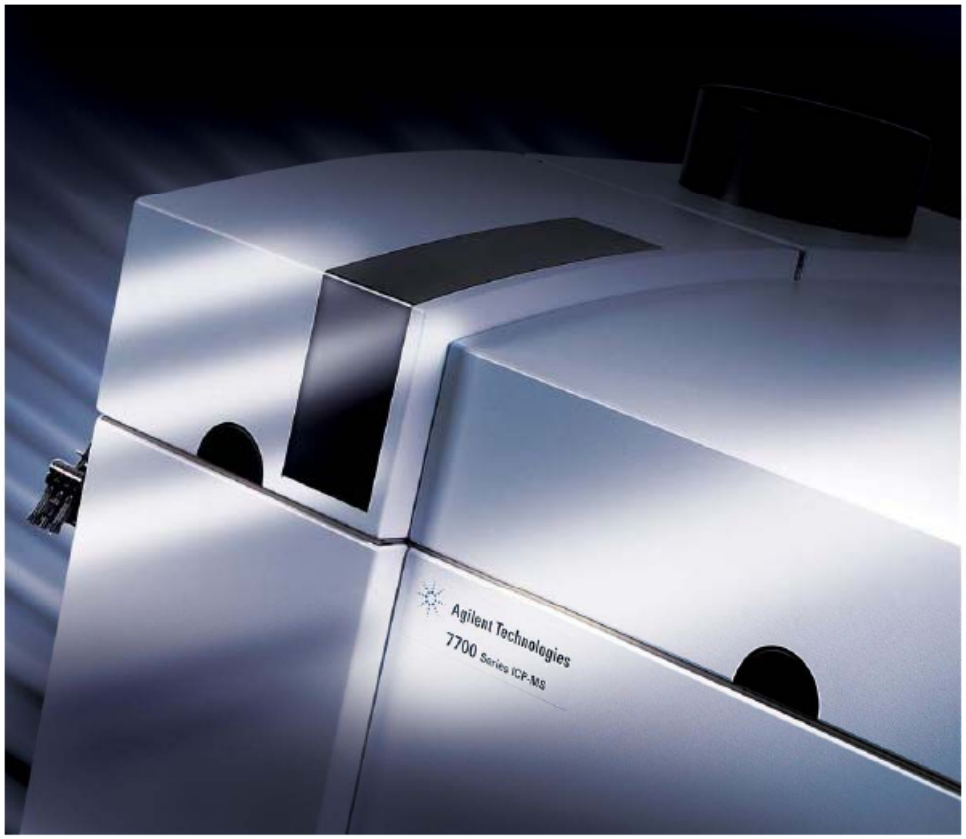
Environmental ICP-MS Methods – Details

EPA methods

- 200.8 Metals in Waters by ICP-MS
- 200.10 Trace elements in marine waters by ICP-MS
- 1638 Trace elements in ambient waters by ICP-MS
- 1640 Trace elements in ambient waters by on-line chelation ICP-MS
- 6020 Trace elements in wastes and waters by ICP-MS

Other ICP-MS methods

- 172.0 (NOAA) Trace metals in marine sediments by ICP-MS
- 172.1 (NOAA) Trace metals in marine animal tissues by ICP-MS
- 3125 (Standard Methods) Metals in water by ICP-MS
- D5673 (ASTM) Metals in water by ICP-MS
- MM100 (DOE) Radionuclides by ICP-MS
- MM800 (DOE) Uranium in water by ICP-MS



The All New Agilent 7700 Series

The Smallest, Most Powerful ICP-MS Ever Made

7700 Series – New Product Highlights

New ORS^3 Collision/Reaction Cell

- Longer, narrower rods, higher cell pressure and frequency – MUCH better performance in He mode

New RF Generator

- Fast tuning 27MHz generator, for better tolerance to changing matrix (incl. organics)

Increased Matrix Tolerance

- High Matrix Introduction (HMI) standard on 7700x model

Much smaller cabinet

- >30% smaller footprint than any other ICP-MS

Simple software; reliable Auto-Tuning

- MassHunter software – intuitive and easy to learn. Pre-set plasma conditions and fast lens auto-tuning

Customer Pain Points

The overarching concern for these environmental labs is to maintain the required level of productivity or through put from the metals labs.

This challenge is complicated by:

- Sensitivity requirements
- Stability requirements
- Sample concentration variance
- Dissolved solids in digested samples

So Why Use the Agilent 7700?

Simply

Much better detection limits (ppt or sub ppt) even after dilution

Fewer, simpler interferences – mostly eliminated using CRC technology ➡ Higher confidence in data quality

One technique is simpler than 2 (or 3)

Single sample prep

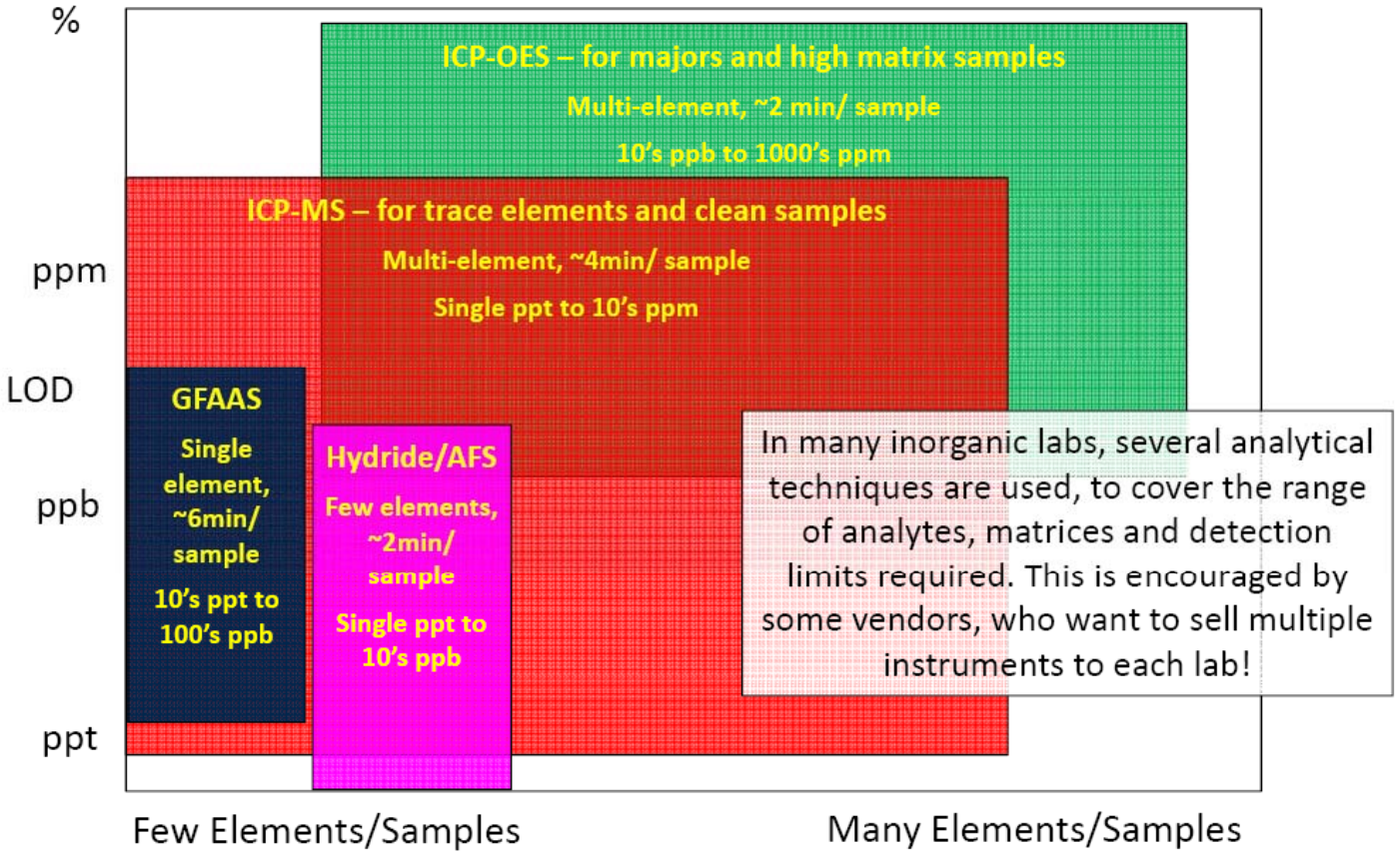
Reduced QA/QC

Simplified reporting

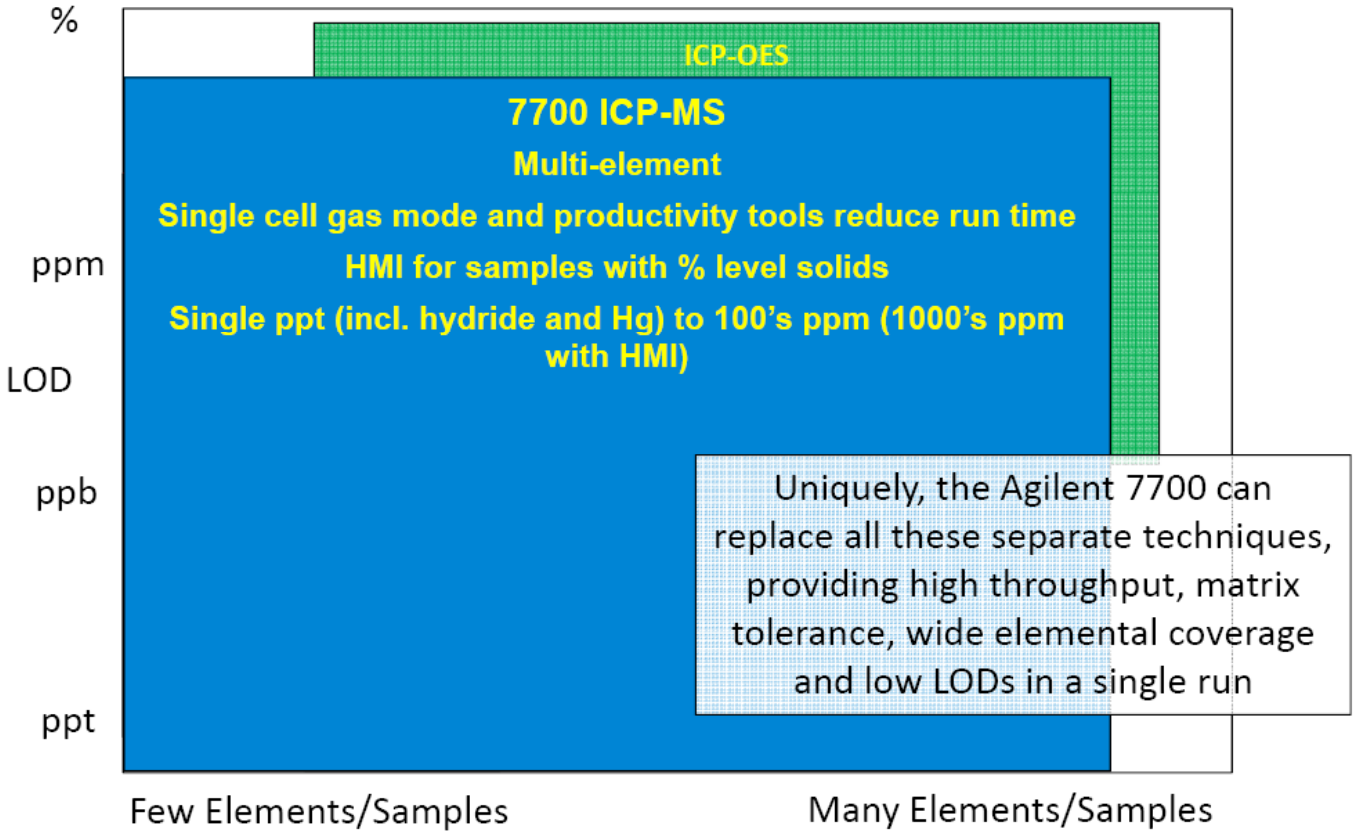
But…

High TDS samples (> 0.1 - 0.2%) require dilution

Inorganic Analysis Techniques in a Typical Laboratory



Inorganic Analysis Techniques in a Typical Laboratory



What Kind of Productivity is Possible?

STL Bridgend (Wales, UK) is the busiest drinking water lab in Europe – the photo shows 12 hours worth of samples for the lab!

STL used a combination of GFAA and ICP-OES for metals. They switched to a single analysis by ICP-MS to increase throughput, installing an Agilent 7500 with ISIS. Max capacity of the 7500 is 280 samples on an overnight run.

A second 7500 was installed when the first system had reached full capacity.

These 2 7500 systems are now analysing 13,000 – 15,000 samples per month between them, measuring 30 elements in every sample.

Severn Trent Laboratories

Thank You For Your Attention. Questions?